

**UNITED STATES PATENT APPLICATION**

of

**CHAD COBBLEY**

for

# PROCESS FOR PROVIDING ELECTRICAL CONNECTION BETWEEN A SEMICONDUCTOR DIE AND A SEMICONDUCTOR DIE RECEIVING MEMBER

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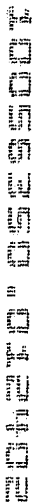
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1 semiconductor industry to reduce packaging costs, to improve electrical and thermal  
2 performance, and to reduce size.

3 An important packaging process is that of mounting and electrically connecting a  
4 semiconductor die to a mounting substrate such as a printed circuit board. A printed circuit  
5 board has a series of internal and external printed wires for electrically connecting two or  
6 more semiconductor dies or other electronic components that are mounted or attached  
7 thereto. Commonly, a semiconductor die is mounted over a receiving member that is in turn  
8 attached to the mounting substrate. Often, the receiving member is also a printed circuit  
9 board. The receiving member has a series of internal electrically conductive traces, each of  
10 which extends between at least two contact sites. One contact site is positioned to provide  
11 electrical connection with a bond pad on the semiconductor die, while the other contact site  
12 is located so as to provide electrical connection with the mounting substrate. Thus, a  
13 semiconductor package assembly formed according to the above-described process includes  
14 a semiconductor die mounted over a receiving member, which is in turn attached to a  
15 mounting substrate.

16 Semiconductor dies are structured according to one of at least two available designs:  
17 wirebond and flip-chip. Wirebond semiconductor dies have a set of bond pads arrayed on  
18 a face thereof. These semiconductor dies are packaged on a mounting substrate such that the  
19 face having the bond pads faces away from the receiving member and the mounting  
20 substrate. The bond pads are then wired to corresponding contact sites on the receiving  
21 member. In contrast, the bond pads of a flip-chip semiconductor die are arrayed on the  
22 opposite face. The face of a flip-chip that has the bond pads is disposed directly on the  
23 receiving member. An array of solder balls or other conductive material provides electrical  
24 connection between the bond pads of the flip-chip and the contact sites of the receiving  
25 member.  
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1 Manufacturers may find it commercially desirable to produce any specific integrated  
2 circuit according to both the wirebond and flip-chip designs. For example, one customer  
3 may demand a flip-chip, while another customer may be satisfied with a wirebond  
4 semiconductor die. However, such dual design of integrated circuits has required two  
5 corresponding receiving members, one configured to receive a flip-chip, and the other to  
6 receive the wirebond semiconductor die. Dual design of receiving members is expensive for  
7 the manufacturer -- it requires increased inventory and redundant design and effort. The cost  
8 of producing and keeping in inventory dual receiving members may make production of  
9 dually designed integrated circuits prohibitive, thereby preventing market demand from being  
10 satisfied. It will be appreciated that a receiving member that is capable of receiving either  
11 a flip-chip or a wirebond semiconductor die, as needed, would be advantageous.

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## **BRIEF DESCRIPTION OF THE DRAWINGS**

In order to illustrate the manner in which the above-recited and other advantages and features of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope, the invention will be described with additional specificity and detail through the use of the accompanying drawings in which:

Figure 1 is a top view of a receiving member configured for receiving an electronic component.

Figure 2 is a top view of another receiving member configured for receiving an electronic component.

Figure 3 is a top view of the receiving member of either Figure 1 or Figure 2, wherein a plurality of first contact sites and a plurality of second contact sites are replaced with contact sites that may be used with either wirebond or flip-chip components.

Figure 4 is a cross section elevation view of the receiving member of Figure 1.

Figure 5 is a cross section elevation view of a semiconductor package assembly including the receiving member of Figure 1 in combination with an electronic component in the flip-chip orientation.

Figure 6 is a cross section elevation view of a semiconductor package assembly including the receiving member of Figure 1 in combination with an electronic component in the wirebond orientation.

Figure 7 is a cross section elevation view of the semiconductor package assembly of Figure 5 attached to a mounting substrate.

1           Figure 8 is a cross section elevation view of a semiconductor package assembly  
2 including the receiving member of Figure 2 in combination with an electronic component  
3 and attached to a mounting substrate.  
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## DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, a semiconductor package assembly is provided that is configured to accept or include either of a flip-chip or a wirebond semiconductor die. In one embodiment of the invention, a receiving member is capable of receiving a semiconductor die in either a flip-chip or wirebond orientation. In a further embodiment, the assembly includes the receiving member attached to a semiconductor die in either the flip-chip or wirebond orientation.

Shown in Figure 1 is a semiconductor die receiving member 10 in a first embodiment. Semiconductor die receiving member 10 has a die receiving surface 12 configured to accept a semiconductor die, an integrated circuit wafer, or another electronic component. The receiving members of the invention are particularly useful for mounting semiconductor dies, but other electronic components that are conventionally mounted over receiving members are contemplated by the invention. Accordingly, semiconductor die receiving member 10 is disclosed herein as a preferred embodiment, but it will be understood that the invention extends to other receiving members configured to accept other electronic components.

A semiconductor die that is to be mounted over semiconductor die receiving member 10 would be positioned over die receiving region 14 of die receiving surface 12. Die receiving region 14 is bounded and defined by a perimeter 16 that corresponds to and has substantially the same dimensions as the periphery of the semiconductor die with which semiconductor die receiving member 10 is to be used. Thus, semiconductor die receiving member 10 is configured to receive a semiconductor die that can be positioned over die receiving region 14, thereby substantially covering die receiving region 14.

As seen in Figure 1, a plurality of first contact sites 18 are arrayed on die receiving surface 12. Preferably, first contact sites 18 are positioned within perimeter 16. Further, a plurality of second contact sites 22 are arrayed on die receiving surface 12, preferably outside



1 of perimeter 16. First and second contact sites 18 and 22 are located on semiconductor die  
2 receiving member 10 to provide electrical connection with a mounted semiconductor die in  
3 the flip-chip and wirebond orientations, respectively. In Figure 1, it can be seen that first  
4 contact sites 18 are configured to lie underneath a semiconductor die when the die is  
5 proximate die receiving region 14. Moreover, second contact sites 22 are configured to lie  
6 adjacent a semiconductor die when the die is proximate die receiving region 14. However,  
7 the invention also extends to all configurations wherein contact sites 18 and 22 are situated  
8 on semiconductor die receiving member in an arrangement whereby electrical connection  
9 may be established with a mounted flip-chip component through first contact sites 18 and  
10 with a mounted wirebond component through second contact sites 22.

11 A plurality of electrically conductive traces 24 (shown in phantom) are contained  
12 within semiconductor die receiving member 10. Traces 24 electrically connect first contact  
13 sites 18 with second contact sites 22. Each trace 24 corresponds with one of first contact  
14 sites 18 and with one of second contact sites 22 such that each first contact site 18 is  
15 electrically connected with exactly one second contact site 22 and vice versa. Further, traces  
16 24 are routed through semiconductor die receiving member 10 to a plurality of terminal  
17 contact sites 26 (shown in phantom) positioned on an external circuitry receiving region of  
18 semiconductor die receiving member 10. Again, each trace 24 corresponds with one of  
19 terminal contact sites 26 such that each terminal contact site 26 is electrically connected with  
20 exactly one trace 24. Traces 24 are insulated from the external environment and one from  
21 another by dielectric material contained in semiconductor die receiving member 10.  
22 Terminal contact sites 26 are intended to provide electrical connection between  
23 semiconductor die receiving member 10 and external circuitry. Accordingly, terminal  
24 contact sites 26 are positioned on any surface of semiconductor die receiving member 10 to  
25 which an electronic component or a device or structure having circuitry may be connected.  
26 As seen in Figure 1, the first preferred embodiment of semiconductor die receiving member

1 10 has terminal contact sites 26 that are exposed on a surface opposite die receiving  
2 surface 12.

3 Semiconductor die receiving member 10 functions to provide power and signal  
4 distribution to and from semiconductor dies mounted thereon and to give rigidity to packaged  
5 semiconductor structures. Semiconductor die receiving member 10 may be any structure,  
6 including multilayer structures, through which traces 24 may be routed between contact sites  
7 18, 22 and 26. It will be recognized by those skilled in the relevant art that a wide variety  
8 of materials may be used in semiconductor die receiving member 10. For example, printed  
9 circuit boards are currently widely used as semiconductor die receiving members. Other  
10 suitable structures include, but are not limited to, fiberglass structures and multilayer  
11 ceramics, such as those containing alumina ceramic. Moreover, semiconductor die receiving  
12 member 10 may be a semiconductor substrate, such as a selectively doped silicon wafer,  
13 silicon on insulator, silicon on sapphire, or the like.

14 Semiconductor die receiving member 10 is produced according to known methods  
15 of printing or constructing conductive wiring and layers within a dielectric or semiconductor  
16 substrate. For example, semiconductor die receiving member 10 may contain a series of  
17 vias, through-holes and deposited metal traces. The dimensions of semiconductor die  
18 receiving member 10 depend on the application in which it is to be used. Often, however,  
19 it will be preferable for semiconductor die receiving member 10 to be a relatively thin,  
20 laminar structure, thereby keeping package size to a minimum.

21 Contact sites 18, 22 and 26 are electrically conductive surfaces to which circuitry  
22 within semiconductor dies or external devices or structures may be connected. Contact sites  
23 18, 22 and 26 may be exposed on semiconductor die receiving member 10 flush with the  
24 surface, such as die receiving surface 12, on which they are positioned. Alternatively,  
25 contact sites 18, 22 and 26 may be recessed from the surface of semiconductor die receiving  
26 member 10 through which they are exposed, in which case they may be merely exposed

1 surfaces of traces 24. In still an alternate form, contact sites 18, 22 and 26 may protrude  
2 beyond the surface of semiconductor die receiving member 10 on which they are exposed.

3 Semiconductor die receiving member 10 may be configured to mount to a mounting  
4 substrate, thereby providing electrical connection between terminal contact sites 26 and  
5 external circuitry. Alternatively, semiconductor die receiving member 10 may contain a  
6 plurality of die receiving regions 14, such that more than one semiconductor die may be  
7 mounted thereon. In one variation on this alternative, semiconductor die receiving member  
8 10 would be mounted over a mounting substrate such that each semiconductor die is  
9 electrically connected with the mounting substrate. In such an embodiment, semiconductor  
10 die receiving member 10 would have pluralities of third, fourth, etc., contact sites to  
11 correspond with the multiple die receiving regions.

12 In another variation on the multiple semiconductor die embodiment, semiconductor  
13 die receiving member 10 may provide for direct electrical interconnection between  
14 semiconductor dies mounted thereon, without use of a separate mounting substrate. For  
15 example, semiconductor die receiving member 10 may be a printed circuit board, such as a  
16 motherboard, designed to accept several semiconductor dies. In such an embodiment, a first  
17 die receiving region would be associated with first contact site 18 and second contact site 22.  
18 A second die receiving region would be associated with at least a third contact site. Trace  
19 24 would lead directly from contact sites 18 and 22 to the third contact site, thereby  
20 electrically connecting the first and second semiconductor dies.

21 As shown in Figure 2, semiconductor die receiving member 20 is a second  
22 embodiment of a structure according to the invention. Semiconductor die receiving member  
23 20 is substantially configured as is semiconductor die receiving member 10 of Figure 1,  
24 differing primarily in the relative arrangement of terminal contact sites 26 and electrically  
25 conductive traces 24 with die receiving region 14. Terminal contact sites 26 are arrayed  
26 along a package mount edge 28 that is laterally adjacent to die receiving surface 12.

1 Figure 3 shows an alternative embodiment of the receiving member of the present  
2 invention. In this embodiment, the plurality of first contact sites 18 and the plurality of  
3 second contact sites 22 of Figures 1 and 2 are combined, thereby providing a plurality of  
4 dual-purpose contact sites 19. In effect, dual-purpose contact sites 19 are provided by  
5 increasing the area extent of and merging first contact sites 18 and second contact sites 22.  
6 Dual-purpose contact sites 19 each have a first portion 21 positioned within perimeter 16 and  
7 a second portion 23 outside of perimeter 16. When a semiconductor die is mounted over die  
8 receiving region 14 in a flip-chip orientation, electrical connection to the semiconductor die  
9 is provided by first portion 21. When a semiconductor die is mounted over die receiving  
10 region 14 in a wirebond orientation, electrical connection to the semiconductor die is  
11 provided by second portion 23. Accordingly, dual-purpose contact sites 19 are configured  
12 to provide electrical connection with a semiconductor die whether in a flip-chip or wirebond  
13 mounting orientation.

14 Figure 4 illustrates semiconductor die receiving member 10 of Figure 1 in cross  
15 section elevation view. As can be seen, terminal contact sites 26 emerge to a package mount  
16 surface 32 opposite die receiving surface 12. Traces 24 allow electrical current and signals  
17 to pass between die receiving surface 12 and package mount surface 32.

18 Referring to Figures 5 and 6, a semiconductor package assembly is shown according  
19 to the invention, including semiconductor die receiving member 10 of Figure 1 in  
20 combination with one of two semiconductor dies: flip-chip semiconductor die 30 and  
21 wirebond semiconductor die 50. Semiconductor dies 30 and 50, which may be memory or  
22 logic chips, represent two alternative methods of configuring a semiconductor die for  
23 connection with external circuitry. Flip-chips are designed with bond pads arranged such  
24 that they may be placed in direct contact with contact sites of a semiconductor die receiving  
25 member. The face of a flip-chip that contains bond pads is disposed on the die receiving  
26 surface. In contrast, wirebond semiconductor dies have bond pads on the opposite surface.

1 A wirebond component is packaged such that the face having bond pads faces away from its  
2 semiconductor die receiving member. Wires are bonded between the bond pads and  
3 corresponding contact sites on the semiconductor die receiving member.

4 Seen in Figure 5 is a connection between semiconductor die receiving member 10  
5 and flip-chip semiconductor die 30. Semiconductor die 30 has a first face 34 and an opposite  
6 second face 36. A plurality of bond pads 38 are arrayed on first face 34. First face 34 is  
7 disposed over die receiving region 14, such that bond pads 38 are aligned with corresponding  
8 first contact sites 18. A conductive material 40 is provided between bond pads 38 and  
9 contact sites 18 to facilitate electrical connection therebetween. Conductive material 40 may  
10 be solder balls, conductive polymer balls, or other suitable conductive material. A dielectric  
11 adhesive underfill 42 is preferably applied between first surface 34 and die receiving region  
12 14 to securely attach semiconductor die 30 to semiconductor die receiving member 10.  
13 Accordingly, semiconductor die 30 is attached to semiconductor die receiving member 10  
14 in the flip-chip orientation, which will also be termed "first orientation" hereinafter.  
15 Electrical connection is provided from bond pad 38 through conductive material 40, first  
16 contact site 18, and trace 24, to terminal contact site 26.

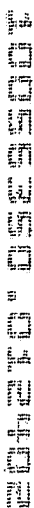
17 Figure 6 depicts semiconductor die receiving member 10 in combination with  
18 wirebond semiconductor die 50. Semiconductor die 50 has a first face 46 and an opposite  
19 second face 48. A plurality of bond pads 52 are arrayed on first face 46. In this embodiment,  
20 semiconductor die receiving member 10 includes a thin adhesive layer 44 disposed on a  
21 portion of die receiving region 14. Adhesive layer 44 is relatively thin in comparison with  
22 the thickness of semiconductor die 50. Second face 48 is disposed directly on adhesive layer  
23 44 to cause a bond to form therebetween. Wiring 54 is extended between bond pads 52 and  
24 second contact sites 22 according to methods known in the art. Thus, semiconductor die 50  
25 is attached to semiconductor die receiving member 10 in the wirebond orientation, which  
26 will also be termed "second orientation" hereinafter. Electrical connection is thereby

1 provided from bond pad 52, through wiring 54, second contact site 22, and trace 24, to  
2 terminal contact site 26.

3 It will be understood that semiconductor die receiving member 20 as illustrated in  
4 Figure 2 is also configured to receive semiconductor dies 30 and 50 of the respective flip-  
5 chip and wirebond designs. Semiconductor dies 30 and 50 may be attached to semiconductor  
6 die receiving member 20 as described above in reference to Figures 5 and 6. Accordingly,  
7 semiconductor package assemblies are provided under the present invention having  
8 semiconductor die receiving member 20 in combination with either of semiconductor die 30  
9 or semiconductor die 50.

10 Turning to Figure 7, a semiconductor package assembly as described above in  
11 reference to Figure 5 is provided, with the addition of mounting substrate 60 on which  
12 semiconductor die receiving member 10 is mounted. As discussed above, the semiconductor  
13 package assembly provides electrical connection between bond pad 38 and terminal contact  
14 site 26. Inclusion of mounting substrate 60 in the semiconductor package assembly allows  
15 electrical connection to extend to external circuitry contained in any chosen component,  
16 device or structure. Mounting substrate 60 has a plurality of contact pads 58 positioned to  
17 correspond to the plurality of terminal contact sites 26. Semiconductor die receiving member  
18 10 is disposed over mounting substrate 60 so as to align terminal contact sites 26 with  
19 corresponding contact pads 58. Semiconductor die receiving member 10 is thereby  
20 positioned parallel to mounting substrate 60. A conductive material 56 is provided at the  
21 interface between terminal contact sites 26 and contact pads 58 to establish electrical  
22 connection therebetween. An adhesive material (not shown) optionally may be used to  
23 strengthen the bond between semiconductor die receiving member 10 and mounting substrate  
24 60.

25 Mounting substrate 60 is commonly a printed circuit board. For example,  
26 semiconductor die receiving member 10 may be mounted over a printed circuit motherboard.



1 However, it will be recognized by those skilled in the relevant art that a wide variety of  
2 structures and materials may serve as a mounting substrate 60. Other suitable structures  
3 include, but are not limited to, fiberglass structures and multilayer ceramics, such as those  
4 containing alumina ceramic. Moreover, mounting substrate 60 may be a semiconductor  
5 substrate, such as a selectively doped silicon wafer, silicon on insulator, silicon on sapphire,  
6 or the like.

7 Mounting substrate 60 is produced according to appropriate known methods, such  
8 as printing or otherwise constructing conductive wiring and layers within a dielectric or  
9 semiconductor substrate. The dimensions of mounting substrate 60 depend on the  
10 application in which it is to be used. Often, however, it will be preferable for mounting  
11 substrate 60 to be a relatively thin, laminar structure, thereby keeping package size to a  
12 minimum. A plurality of semiconductor die receiving members 10, with their corresponding  
13 semiconductor dies, may be mounted over a mounting substrate, thereby providing  
14 communication and coordination between two or more semiconductor dies.

15 Referring to Figure 8, a semiconductor package assembly in a further embodiment  
16 is shown, including semiconductor die receiving member 20, semiconductor die 30 in the  
17 flip-chip orientation, and mounting substrate 60. Alternatively, semiconductor die 50 in the  
18 wirebond orientation can be substituted for semiconductor die 30 in the flip-chip orientation.  
19 Mounting substrate 60 has a plurality of contact pads 58 that correspond to terminal contact  
20 sites 26. Semiconductor die receiving member 20, with mounted semiconductor die 30, is  
21 positioned so that package mount edge 28 is positioned over mounting substrate 60, with  
22 terminal contact sites 26 being aligned with corresponding contact pads 58. Semiconductor  
23 die receiving member 20 is conductively attached to mounting substrate 60 such that a  
24 conductive interface is formed between terminal contact sites 26 and contact pads 58.  
25 Semiconductor die receiving member 20 is thereby positioned substantially orthogonal  
26 relative to mounting substrate 60. Alternatively, semiconductor die receiving member 20

1 may connect with mounting substrate 60 in an oblique angle. In this embodiment, mounting  
2 substrate 60 in Figure 8 may be any structure or material as described above in reference to  
3 mounting substrate 60 in Figure 7.

4 The semiconductor package assembly as described above in reference to Figure 8  
5 is commonly known as a card-on-board assembly, where mounting substrate 60 is a board,  
6 or motherboard, and semiconductor die receiving member 20 is a card, or a "daughter-  
7 board". The card-on-board assembly is especially useful for efficiently packaging memory  
8 chips, whereas logic chips are more frequently packaged according to the assembly described  
9 above in reference to semiconductor die receiving member 10.

10 According to the above described and other embodiments, a versatile semiconductor  
11 die receiving member and associated semiconductor package assembly are disclosed. The  
12 assembly accepts semiconductor dies in either the flip-chip or wirebond orientation.  
13 Moreover, the semiconductor die receiving member may be attached to a mounting substrate  
14 in a parallel or orthogonal orientation.

15 The present invention has application to a wide variety of semiconductor packaging  
16 assemblies other than those specifically described herein. The present invention may be  
17 embodied in other specific forms without departing from its spirit or essential characteristics.  
18 The described embodiments are to be considered in all respects only as illustrative and not  
19 restrictive. The scope of the invention is, therefore, indicated by the appended claims rather  
20 than by the foregoing description. All changes which come within the meaning and range  
21 of equivalency of the claims are to be embraced within their scope.  
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